

Increased risk of nonalcoholic fatty liver disease with occupational stress in Chinese policemen

A 4-year cohort study

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Abstract

Nonalcoholic fatty liver disease (NAFLD) and occupational stress have been recognized as major public health concerns. We aimed to explore whether occupational stress was associated with NAFLD in a police population.

A total of 6559 male police officers were recruited for this prospective study in April 2007. Among them, 2367 eligible subjects participated in follow-up from 2008 to 2011. NAFLD was diagnosed based on standard criteria. Occupational stress was evaluated by Occupational Stress Inventory-Revised scores.

The incidence of NAFLD was 31.2% in the entire police. After adjusting for traditional risk factors, moderate occupational stress (MOS), high occupational stress (HOS), and high personal strain (HPS) were risk factors (MOS: hazard ratio [HR]=1.237, 95% confidence interval [CI]=1.049–1.460; HOS: HR=1.727, 95% CI=1.405–2.124; HPS: HR=3.602, 95% CI=1.912–6.787); and low occupational stress (LOS) and low personal strain (LPS) were protective factors (LOS: HR=0.366, 95% CI=0.173–0.776; LPS: HR=0.490, 95% CI=0.262–0.919) for NAFLD in the entire police cohort. HOS and HPS remained robust among traffic police.

HOS and HPS were independent predictors for the development of NAFLD in a Chinese police population. Additional future prospective investigations are warranted to validate our findings.

Abbreviations: ALT = alanine aminotransferase, BMI = body mass index, BP = blood pressure, CI = confidence interval, FPG = fasting plasma glucose, HCR = high coping resources, HDL-C = high-density lipoprotein cholesterol, HR = hazard ratio, IR = insulin resistance, LDL-C = low-density lipoprotein cholesterol, LOS, NOS, MOS, and HOS = low, normal, moderate, and high occupational stress, LPS, NPS, MPS, and HPS = low, normal, moderate, and high personal strain, MetS = metabolic syndrome, MLCR = moderate lack of coping resources, NAFLD = nonalcoholic fatty liver disease, NASH = nonalcoholic steatohepatitis, ORQ = occupational roles questionnaire, OS = oxidative stress, OSI-R = Occupational Stress Inventory-Revised, PRQ = personal resources questionnaire, PSQ = personal strain questionnaire, SD = standard deviation, SDCR = significant deficits in coping resources, TC = total cholesterol, TG = triglycerides.

Keywords: cohort study, nonalcoholic fatty liver disease, occupational stress, police officers

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1. Introduction

Nonalcoholic fatty liver disease (NAFLD) has been a major public health issue and gained increasing attention in both clinical studies and as a research-focus due to its potential effects on individual health over the past several years.^[1] The prevalence of NAFLD, in the Chinese general population, is reported to be 20% (6.3–27.0%), which is increasing with a rapid increase in obesity and other metabolic syndromes (MetS).^[2–4]

As far as we know, NAFLD, which is characterized by an increased accumulation of fat in the liver without excessive alcohol consumption, represents a wide spectrum of diseases ranging from simple steatosis to nonalcoholic steatohepatitis (NASH) or cirrhosis.^[2] Several large population studies have reported that NAFLD is closely associated with increased rates of mood disorders and stress.^[5,6] The lifetime prevalence of major depressive disorder and generalized anxiety disorder were higher in patients with NASH than in control subjects (63.8% vs 33.3%) after matching for covariates.^[6] Moreover, occupational stress is becoming a major working-mental health issue that could lead to less cooperation, low productivity, regular absenteeism, and poor quality of life.^[7] Previous studies indicate that policing is one of the most stressful occupations, and high work stress is associated with MetS in police officers.^[8,9] However, little is known about the relationship between occupational stress and NAFLD, especially in

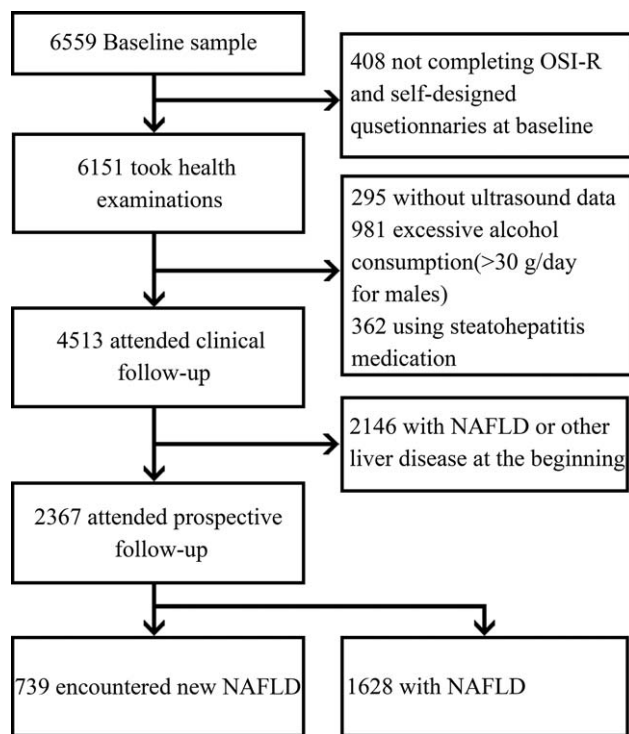


Figure 1. Flow chart of the study population.

Chinese police officers, who play a pivotal role in modern society and have relatively high stress due to exposure to potential violence and life-threatening events in the daily workplaces.^[9]

Current estimates suggest that occupational stress can be evaluated using various questionnaires.^[10] The Occupational Stress Inventory-Revised (OSI-R) questionnaire, which is confirmed to have a good reliability and validity in different occupational populations, has been widely used to assess the degree of occupational stress, and to analyze the relationship between occupational stress and healthy disorders.^[11] Thus, our study was established to examine the relationship between occupational stress based on OSI-R scores and the incidence of NAFLD in a police cohort in Tianjin, China.

2. Methods

2.1. Study population

All the subjects in our study were recruited in April 2007 at the Medical Center of Police Hospital in Tianjin, China, where medical examinations are provided to both working and retired policemen every year.^[9,11] A total of 6559 male police officers (aged 20–60 years) participated in the study; they received free health examinations, and completed the OSI-R questionnaire and interviewer-administered questionnaires. Among them, 4192 participants were excluded based on the following criteria: 408 did not complete the OSI-R and self-designed questionnaires at baseline; 295 had missing ultrasound scanning data; 981 had a history of or concurrent alcohol abuse (more than 30 g/d for males)^[12]; 362 were using steatohepatitis medication; 2146 had been diagnosed with NAFLD, chronic hepatitis B or C, autoimmune hepatitis or other liver diseases at the beginning of the study. Ultimately, the other 2367 subjects agreed to be followed up with dynamic observations each year from 2008 to 2011 (see Fig. 1 for a subject flowchart).

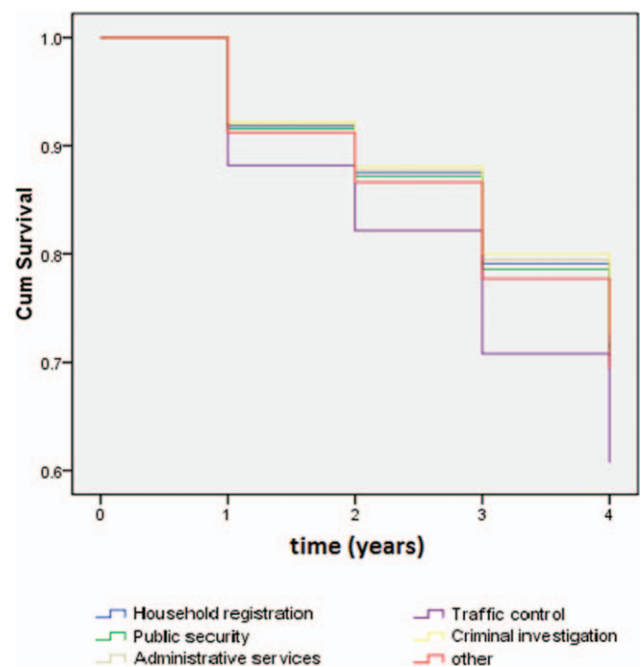


Figure 2. Kaplan-Meier survival curves for different police populations.

This survey protocol was approved by the ethics committee of Tianjin Medical University (Tianjin, China) and the Tianjin Public Health Bureau (Tianjin, China). We received written consent from all the participants at baseline.

2.2. Clinical and laboratory assays

All the subjects underwent clinical and laboratory assays that included anthropometric measurements, abdominal ultrasonographic scanning, and biochemical measurements.

The anthropometric measurements included height, weight, waist circumference, hip circumference, and blood pressure (BP). BP was measured 3 times with an Electronic Sphygmomanometer (XW-200, made in Shenzhen, China) after 5 min of rest, and we calculated the average.^[9] Ultrasonic scanning was performed in all the participants by an experienced radiologist in a double-blinded fashion. Fasting blood samples were obtained via venipuncture by well-trained clinical nurses from 8 am until noon, and were sent to a laboratory in police hospital <60 min after collection.^[11] Biochemical values including alanine aminotransferase (ALT), total cholesterol (TC), triglycerides (TG), high- and low-density lipoprotein cholesterol (H/LDL-C), and fasting plasma glucose (FPG) were tested using an Automatic Biochemical Analyzer (TBA-120FR, Toshiba Corp, made in Shanghai, China) with standard laboratory procedures.^[9]

2.3. Measurement of occupational stress

Occupational stress was measured with the Chinese version of the OSI-R, which is a self-report questionnaire and a psychometrically validated stress instrument that includes 3 individual scales: the Occupational Roles Questionnaire (ORQ), Personal Strain Questionnaire (PSQ), and Personal Resources Questionnaire (PRQ).^[13] To provide individual levels, the OSI-R scores were transformed into standard T scores. Then, we divided our sample into 4 groups according to T scores: low stress and strain (≤ 40 ; LOS/LPS), normal stress and strain (40–59; NOS/NPS), moderate stress and strain

(60–69; MOS/MPS), and high stress and strain (≥ 70 ; HOS/HPS) for ORQ and PSQ; and significant deficits in coping resources (< 30 ; SDCR), moderate lack of coping resources (30–39; MLCR), average coping resources (40–59), and high coping resources (≥ 60 ; HCR) for PRQ.^[13] In particular, the OSI-R questionnaire used in the present study was confirmed to have good reliability and internal consistency for Chinese policemen (Cronbach alpha: OSI-R=0.883, ORQ=0.908, PSQ=0.934, and PRQ=0.909).^[11]

2.4. Diagnosis of NAFLD

The standard criteria for the diagnosis of NAFLD were based on the ordinance issued by the Fatty Liver Disease Study Group of the Chinese Liver Disease Association^[14]: exclusion of other liver diseases, such as alcohol or drug-induced liver diseases, autoimmune or viral hepatitis, metabolic liver disease, and genetic liver disease^[1]; laboratory tests: elevated ALT (> 29 IU/L)^[15]; and abdominal ultrasonic examinations: increased hepatic echogenicity compared with the spleen and kidneys, blurring of liver vasculature, and deep attenuation of ultrasonographic signals through the right hepatic lobe.

2.5. Measurements of covariates

Thorough socioeconomic and demographic variables were collected based on interviewer-administered questionnaires. Those characteristics included age (< 45 , 45–54, or ≥ 55), body mass index (BMI; < 18.5 , 18.5–24.99, 25–29.99, or ≥ 30),^[16] marital status (married or other), educational level (lower than college or college and above), office work, working strength (≤ 8 or > 8 h), smoking status (nonsmoker, current smoker, or former smoker), alcohol status (nondrinker, current drinker, or former drinker), physical exercise (never or seldom, occasionally, often, or every day), and MetS-related factors (central obesity; hypertension; elevated TG; reduced HDL-C, or raised FPG). Among them, BMI was calculated as body weight (in kilograms) divided by the square of body height (in square meters).^[16]

MetS was diagnosed using the New International Diabetes Federation worldwide definition.^[17] The criteria were central obesity (waist circumference ≥ 90 cm in males) plus at least 2 of the 4 following factors:

1. Raised BP (systolic BP ≥ 130 or diastolic BP ≥ 85 mm Hg) or reported antihypertensive treatments.
2. Elevated TG levels (≥ 1.7 mmol/L) or reported treatments with this abnormalities.
3. Reduced HDL-C (< 1.03 mmol/L in males) or reported treatments with this lipid abnormalities.
4. Raised FPG (≥ 5.6 mmol/L) or reported diagnosed diabetes.

2.6. Statistical analysis

Mann–Whitney *U* test was conducted for continuous variables, and a Chi-squared test for categorical variables, which were reported as means \pm standard deviations (SD) or frequencies, to compare the differences between subjects with and without NAFLD. Univariate Cox-proportional hazards regression analysis was performed to identify risk factors related to NAFLD. Cox-proportional hazards regression models were applied to explore predictors for the development of NAFLD before and after adjusting for covariates, such as age, BMI, marital status, office

work, working strength, educational level, smoking status, alcohol intake, physical exercise, police assignments, central obesity, raised BP, elevated TG, reduced HDL-C, and raised FPG and MetS. Meanwhile, Kaplan–Meier survival curve and the log-rank test were conducted to compare cumulative survival rate on different police assignments. All the statistical analyses were performed using SPSS 19.0 software (IBM, Chicago, IL). A 2-tailed $P < 0.05$ was considered statistically significant. For multiple comparisons, the adjusted *P* value based on Bonferroni method was considered credible for estimating statistically significant.

3. Results

3.1. Baseline characteristics of the cohort population and comparison between NAFLD nononset and new-onset groups

The final study included 2367 subjects with a mean age of 36.65 (SD=9.37) years. During a 4-year follow-up (median time: 2.61 years, 25th to 75th percentiles: 1.53–3.75 years), 739 participants (31.2%) developed new NAFLD. The prevalence rates (number of new cases) were 9.5% (225) in 2008, 4.8% (113) in 2009, 9.5% (226) in 2010, and 7.4% (175) in 2011.

Compared to the nononset subjects, those new-onsets had higher ORQ and PSQ scores; higher waist and hip circumferences; and higher levels of BMI, ALT, TG, and HDL-C. Categorical variables including office work, police assignments, central obesity; hypertension; elevated TG; and reduced HDL-C and MetS were significantly different between the groups, whereas no significant difference was noted in terms of age, TC, LDL-C, marital status, educational level, working strength, current smoking status, current alcohol intake, physical exercise, and raised FPG or PRQ scores (Table 1).

3.2. Association between occupational stress and NAFLD in all police officers

Before adding occupational stress to the model, we primarily found that age, BMI, police assignments, central obesity; hypertension; elevated TG; and reduced HDL-C and MetS were predictive for the occurrence of NAFLD (Table 2).

The results of the Cox-proportional hazards regression also indicated that, before and after adjusting for traditional risk factors, MOS, HOS, and HPS were risk factors for NAFLD (MOS: hazard ratio [HR]=1.237, 95% confidence interval [CI]=1.049–1.460; HOS: HR=1.727, 95% CI=1.405–2.124; HPS: HR=3.602, 95% CI=1.912–6.787). In addition, LOS and LPS were protective factors against NAFLD (LOS: HR=0.366, 95% CI=0.173–0.776; LPS: HR=0.490, 95% CI=0.262–0.919) (Table 3).

3.3. Association between occupational stress and NAFLD in traffic police officers

Figure 2 indicates that the incidence of NAFLD in traffic police was significantly higher than in other police. After adjusting for traditional risk factors in the subgroup of traffic police, Table 4 shows that HOS and HPS were still risk factors (HOS: HR=1.895, 95% CI=1.363–2.633; HPS: HR=3.334, 95% CI=1.012–9.985) and LOS was still a protective factor (with lower HR: 0.138) for NAFLD. We also observed that MLCR (HR=0.601) and HCR (HR=0.163), which were not significant in the

Table 1**Baseline characteristics of the study population and comparison between nonalcoholic fatty liver disease nononset group and the new-onset group.**

	Total subjects (n=2367)	Nononsets (n=1628)	New-onsets (n=739)	P
Age, y	36.65±9.37	36.54±9.35	36.91±9.40	0.378
Waist circumference, cm	88.24±7.80	87.04±7.67	90.86±7.43	<0.001
Hip circumference, cm	98.92±5.77	98.10±5.50	100.75±5.92	<0.001
BMI, kg/m ²	24.37±2.82	23.91±2.72	25.37±2.75	<0.001
ALT, mmol/L	17.05±5.60	16.54±5.56	18.14±5.52	<0.001
TC, mmol/L	3.99±0.66	3.98±0.67	4.01±0.65	0.228
TG, mmol/L	1.28±0.88	1.23±0.83	1.40±0.89	<0.001
HDL-C, mmol/L	1.29±0.25	1.31±0.24	1.25±0.24	<0.001
LDL-C, mmol/L	2.14±0.60	2.13±0.60	2.15±0.58	0.638
Married status (married, %)	91.2	90.7	92.2	0.257
Educational level (college and above, %)	97.5	97.6	97.4	0.798
Office work (yes, %)	28.8	30.0	26.0	0.043
Working strength (>8 h, %)	56.1	56.0	56.6	0.784
Current smoking, %	52.8	52.8	52.6	0.433
Current alcohol intake, %	88.3	88.5	88.0	0.809
Physical exercise (regular, %)	22.4	22.9	21.4	0.266
Police assignments, %				<0.001
Household registration	13.5	13.6	13.4	
Public security	26.4	27.3	24.2	
Administrative services	15.0	16.2	12.3	
Traffic control	26.1	22.9	33.0	
Criminal investigation	12.1	13.1	10.0	
Other	7.0	6.9	7.0	
Central obesity (yes, %)	46.6	39.8	61.7	
Raised BP				<0.001
Systolic BP (≥130 mm Hg, %)	27.9	21.5	29.0	<0.001
Diastolic BP (≥85 mm Hg, %)	21.9	20.3	25.4	0.006
Elevated TG (≥1.7 mmol/L, %)	17.9	15.5	23.4	<0.001
Reduced HDL-C (<1.03 mmol/L, %)	17.6	15.0	23.4	<0.001
Raised FPG (≥5.6 mmol/L, %)	6.3	5.4	6.7	0.234
MetS (yes, %)	10.8	8.8	15.4	<0.001
ORQ	59.24±9.73	57.94±9.85	60.09±8.81	<0.001
PSQ	51.96±6.77	51.53±6.85	52.90±6.49	<0.001
PRQ	52.94±10.40	52.68±10.81	53.11±9.89	0.084

ALT=alanine aminotransferase, BMI=body mass index, BP=blood pressure, FPG=fasting plasma glucose, HDL-C=high-density lipoprotein cholesterol, LDL-C=low-density lipoprotein cholesterol, MetS=metabolic syndrome, ORQ=occupational roles questionnaire, PRQ=personal resources questionnaire, PSQ=personal strain questionnaire, TC=total cholesterol, TG=triglycerides.

overall police, trend to be protective factors in the traffic police officers.

4. Discussion

To the best of our knowledge, NAFLD has been considered to be a main cause of chronic liver disease in both developed and developing countries, affected about 30% of the general population.^[1,3] In the developed countries, like North America, Japan, Northern and Southern Europe, South America, Australia, and the Middle East, the prevalence of NAFLD varies from 20% to 46%.^[18] Partly because of different dietary habits and body composition differences in fat and muscle, the prevalence of NAFLD in the Asian countries is 20% in China; 27% in Hong Kong; and ranges from 15% to 45% in South Asia, South-East Asia, Korea, and Taiwan.^[11] In our present study, approximately one-third (31.2%) of the participants developed new NAFLD during the follow-up. HOS and HPS were independent predictors for the development of NAFLD in a Chinese police population. However, given that NAFLD is often asymptomatic,^[1] limited studies have investigated the association between NAFLD and occupational stress.

Although several published studies have reported that depression and anxiety is associated with NAFLD, controversy remains about the relationship between depression and NAFLD. On one hand, a 2011 study with a small sample size demonstrated no clear relationship between NAFLD and depression.^[19] Lee et al^[20] found that depression did not independently influence the incidence of NAFLD at the population level after controlling for covariates. On the other hand, a case-control study demonstrated that depression and anxiety could impact the severity and progression of NASH.^[6] Similarly, a population-based study showed a higher rate of depression in patients with NAFLD (27.2%) than in patients with chronic hepatitis B (3.7%).^[5] At the same time, compared to both a healthy population and patients with hepatitis B or C, a lower quality of life was found in patients with NAFLD.^[21,22] Another cross-sectional study analyzing 567 adult-NAFLD patients proposed that subclinical (odds ratio [OR]=2.1, 95% CI=1.0–4.4) and clinical (OR=3.6, 95% CI=1.4–8.8) depression were associated with a significantly higher degree of hepatocyte ballooning.^[23] In addition, a meta-analysis based on 166,631 individuals and a mean 9.5 years of follow-up, found a noticeable relationship between high psychological distress and liver disease mortality (HR=2.59), especially in the subgroup of subjects with

Table 2**Cox-regression analyses of traditional risk factors associated with nonalcoholic fatty liver disease.**

	HR	95% CI	P
Age (per 10 y)			0.021
<45	1	Reference	
45–54	0.788	(0.640, 0.971)	0.025
≥55	0.676	(0.461, 0.991)	0.045
BMI, kg/m ²			<0.001
<18.5	0.683	(0.303, 1.536)	0.356
18.5–24.99	1	Reference	
25–29.99	1.477	(1.235, 1.769)	<0.001
≥30	1.661	(1.108, 2.488)	0.014
Marital status	0.949	(0.723, 1.246)	0.708
Educational level	0.885	(0.552, 1.420)	0.613
Office work	0.905	(0.748, 1.095)	0.306
Working strength, h	1.012	(0.869, 1.178)	0.617
Smoking status			0.650
Nonsmoker	1	Reference	
Current smoker	1.044	(0.890, 1.224)	0.596
Former smoker	1.122	(0.875, 1.238)	0.365
Alcohol status			0.680
Nondrinker	1	Reference	
Current drinker	0.947	(0.733, 1.224)	0.579
Former drinker	1.174	(0.721, 1.913)	0.480
Physical exercise			0.465
Never or seldom	1	Reference	
Occasionally	1.121	(0.883, 1.424)	0.348
Often	0.969	(0.722, 1.300)	0.835
Everyday	1.150	(0.806, 1.641)	0.441
Police assignments			<0.001
Household registration	1	Reference	
Public security	1.021	(0.796, 1.310)	0.967
Administrative services	0.911	(0.682, 1.216)	0.484
Traffic control	1.602	(1.256, 2.044)	<0.001
Criminal investigations	0.911	(0.672, 1.236)	0.431
Other	1.117	(0.797, 1.564)	0.541
Central obesity	1.493	(1.213, 1.837)	<0.001
Raised systolic BP	1.478	(1.160, 1.883)	0.006
Raised diastolic BP	1.423	(1.090, 1.856)	0.005
Elevated TG	1.274	(1.016, 1.598)	0.041
Reduced HDL-C	1.289	(1.036, 1.603)	0.022
Raised FPG	1.370	(0.960, 1.681)	0.798
Metabolic syndrome	1.509	(1.225, 1.859)	0.001

Bonferroni method was conducted for multiple testing.

BMI=body mass index, BP=blood pressure, CI=confidence interval, FPG=fasting plasma glucose, HDL-C=high-density lipoprotein cholesterol, HR=hazard ratio, TG=triglycerides.

NAFLD.^[24] There is also growing evidence that children and adolescents with NAFLD have a higher rate of psychological distress compared with healthy or obese controls.^[25,26] Furthermore, in the present research, occupational stress was demonstrated to be a risk factor for NAFLD among Chinese police officers.

Looking at various studies around the world, about 25% to 30% of police officers have a stress-related physical health problem,^[27,28] with an explanation that they are exposed to numerous types of risk factors including environmental stress, administrative pressure, rotating shifts, high work load, depression, less sleep, poor nutrition, and less physical activities.^[29–31] A few studies have suggested that work stress is associated with higher prevalence of MetS in police officers who belong to a community with more adverse risk factors and higher mortality rates than the general population.^[32–34] Hartley et al^[27] also found a positive association between job stress and the number of

MetS components. And a cohort study demonstrated that occupational stress was an independent predictor of diabetes.^[11,35] Additionally, NAFLD is a hepatic manifestation of MetS (i.e., associated with those traditional risk factors).^[32,36,37] Thus, we further analyzed the association between occupational stress and NAFLD after adjusted MetS-related factors.

Compounding this issue is the well-known fact that physical activity has been one of the most important protectors against MetS and cancers worldwide,^[38–40] as well as a dose-dependent relationship between exercise and quality of life improvements.^[41–43] In one study, Franke and Anderson^[44] reported that exercise could reduce cardiovascular disease risk via modifying major risk factors in a law enforcement office population (>48 years of age). And Heneweer et al^[39] suggested that better physical fitness can be helpful for the prevention of low back pain. In another study, Pollock et al^[45] showed that middle-aged police officers have lower levels of physical fitness and higher disease risk than younger police officers (<30 years old). Meanwhile, a 15-year cohort study has proved that physical activity in the early adulthood can predict the physical fitness of middle-aged police,^[46] along with that police officers usually display high job-related physical activity levels and can complete all police tasks on their daily work.^[39,47,48] However, there is a correlation between physical activity levels and police duties, which requiring different demands.^[38] Ramey et al^[49] also pointed that police officers tend to be less active on their work days than during off-duty hours. While in our current study, regular physical activity levels have no difference between NAFLD nononset and new-onset groups ($P=0.266$). The explanation could be that we used self-reported physical activity questionnaires, which could be affected by self-images and have recall bias. Thus, further studies are required to investigate this factor in detail.

Another interesting result of our study was that occupational stress is more related with NAFLD in traffic police population. The rapid economic growth and massive transportation developments in modern China have been accompanied by increases in workloads, urbanization and automobile use, along with severe air pollution, and high traffic noise.^[9] Additionally, the Chinese traffic police are a full-time traffic control staff and are exposed to air pollution and traffic noise almost every day.^[9,11] Mounting evidence has demonstrated that a heavy workload and high noise and air pollution cannot only damage people's physical and mental health but also mediate the pathogenesis of NAFLD via insulin resistance (IR), inflammation or oxidative stress (OS).^[50,51] Thus, we assumed that environmental factors might play a vital role in the association between NAFLD and occupational stress.

The mechanisms by which occupational stress affects NAFLD remain unclear and complex. Several plausible mechanisms have been proposed, including cytokine-related inflammation, activation of the hypothalamic-pituitary-adrenal axis, IR, OS, and several indirect mechanisms.^[3,52] First, cytokines such as interleukin-1, interleukin-6, and tumor necrosis factor- α have been postulated to be responsible for the changes in depression in inflammatory patients.^[53] These cytokines, which have been demonstrated to be involved in the pathogenesis of NASH,^[53,54] can cause depressive symptoms by inducing dysfunctions in brain neurotransmission and a similar "sickness behavior" in a mouse model.^[55,56] Second, a growing body of evidence has suggested that depression can continuously activate and overstimulate the hypothalamic-pituitary-adrenal axis to increase cortisol secretion, which is associated with IR in the control of liver fat

Table 3**Cox-regression analyses of T-scores associated with nonalcoholic fatty liver disease in all police officers.**

	Nonadjusted model		Model 1		Model 2		Model 3	
	HR (95% CI)	P	HR (95% CI)	P	HR (95% CI)	P	HR (95% CI)	P
ORQ		<0.001		<0.001		<0.001		<0.001
LOS	0.336 (0.159, 0.711)	0.004	0.355 (0.168, 0.753)	0.007	0.362 (0.171, 0.766)	0.008	0.366 (0.173, 0.776)	0.009
NOS	1		1		1		1	
MOS	1.312 (1.116, 1.542)	0.001	1.238 (1.050, 1.460)	0.011	1.242 (1.053, 1.465)	0.010	1.237 (1.049, 1.460)	0.012
HOS	2.054 (1.683, 2.505)	<0.001	1.724 (1.407, 2.114)	<0.001	1.743 (1.419, 2.140)	<0.001	1.727 (1.405, 2.124)	<0.001
PSQ		<0.001		<0.001		<0.001		<0.001
LPS	0.433 (0.232, 0.809)	0.009	0.450 (0.240, 0.842)	0.013	0.470 (0.251, 0.879)	0.018	0.490 (0.262, 0.919)	0.026
NPS	1		1		1		1	
MPS	1.054 (0.852, 1.304)	0.628	1.011 (0.815, 1.255)	0.918	1.019 (0.818, 1.268)	0.868	1.008 (0.810, 1.256)	0.940
HPS	3.148 (1.685, 5.882)	<0.001	3.420 (1.818, 6.431)	<0.001	3.614 (1.921, 6.799)	<0.001	3.602 (1.912, 6.787)	<0.001
PRQ		0.054		0.083		0.109		0.151
SDCR	1.123 (0.953, 1.324)	0.167	1.124 (0.951, 1.329)	0.170	1.114 (0.941, 1.318)	0.212	1.096 (0.925, 1.298)	0.289
MLCR	1.049 (0.803, 1.370)	0.724	0.927 (0.766, 1.318)	0.974	1.018 (0.775, 1.336)	0.900	1.015 (0.773, 1.332)	0.916
ACR	1		1		1		1	
HCR	0.465 (0.240, 0.899)	0.023	0.495 (0.255, 0.960)	0.037	0.505 (0.261, 0.980)	0.043	0.515 (0.265, 1.000)	0.050

ACR and HCR=average and high coping resources, BP=blood pressure, CI=confidence interval, FPG=fasting plasma glucose, HDL-C=high-density lipoprotein cholesterol, HR=hazard ratio, LOS, NOS, MOS, and HOS=low, normal, moderate, and high occupational stress, LPS, NPS, MPS, and HPS=low, normal, moderate, and high personal strain, MetS=metabolic syndrome, MLCR=moderate lack of coping resources, ORQ=occupational roles questionnaire, PRQ, personal resources questionnaire, PSQ, personal strain questionnaire, SDCR=significant deficits in coping resources, TG=triglycerides.

Model 1 adjusted=age, body mass index, marital status, educational level, smoking status, alcohol intake, and police assignments.

Model 2 adjusted=all above covariates plus office work, working strength, and physical exercise.

Model 3 adjusted=all above covariates plus metabolic abnormalities: central obesity, raised BP, elevated TG, reduced HDL-C, and raised FPG and MetS.

accumulation.^[24,51] Guevara et al^[57] also discovered that measurable changes in brain density were related to liver disease. Furthermore, some reports have revealed that depression and anxiety are potentially connected to IR,^[7,51] and higher OS markers were found in a group of patients with depression versus control subjects.^[58] Third, according to the “multiple-hit” theory, IR and OS are involved in the process of NAFLD,^[24] both of which can lead to greater accumulation of hepatic TG and

disorders of lipid metabolism.^[59] Another mechanism may involve a battery of unhealthy behaviors, such as excessive drinking, cigarette smoking, and overeating, which can be brought by occupational stress.^[60] Subsequently, in parallel to these behaviors, serum leptin levels decrease and triglyceride levels increase, resulting in a high prevalence of NAFLD or other MetS.^[60]

4.1. Limitations

It is notable that our study examined whether occupational distress was correlated with NAFLD in a police population after adjusting for baseline demographic and socioeconomic variables, which could have clinical and therapeutic implications as well as provide further information to investigators about the underlying mechanisms.

However, there are several limitations of our research. First, the scale that was used in our study might be a crude measure, although has been validated for evaluating occupational stress.^[10] Additionally, we recorded OSI-R scores via questionnaires at baseline only, with no reassessments during the follow-up years. Second, considering the large sample size of our study, we utilized blood tests (based on ALT) and ultrasonography as screening tools, which were relatively sensitive, low cost, and widely available to all subjects.^[61] However, the sensitivity was lower than that of liver biopsy, which is the “gold standard” for diagnosis of NAFLD.^[61] Third, NAFLD had appeared to be associated with air pollution and traffic noise.^[62] However, we did not obtain comprehensive nutrition and environmental monitoring data, regarding the nutritional status, air pollution status, and traffic noise levels, encountered by police officers. Thus, it is difficult to confirm the precise influence of nutrition and environmental factors on NAFLD and occupational stress. Lastly, the number of female police officers in our study is relatively small (n=501) versus male officers (n=6559) and the incidence of NAFLD in policewomen is also relatively low (5.6%), so we just analyzed and compared male data in the end.

Table 4**Cox-regression analyses of T-scores associated with nonalcoholic fatty liver disease among traffic officers.**

	HR	95% CI	P
ORQ			<0.001
LOS	0.138	(0.019, 0.994)	0.049
NOS	1	Reference	
MOS	1.058	(0.781, 1.434)	0.715
HOS	1.895	(1.363, 2.633)	<0.001
PSQ			0.032
LPS	0.248	(0.061, 1.008)	0.051
NPS	1	Reference	
MPS	0.814	(0.530, 1.250)	0.347
HPS	3.334	(1.012, 9.985)	0.048
PRQ			0.045
SDCR	1.149	(0.844, 1.563)	0.378
MLCR	0.601	(0.353, 1.023)	0.061
ACR	1	Reference	
HCR	0.163	(0.023, 1.179)	0.052

ACR and HCR=average and high coping resources, BP=blood pressure, CI=confidence interval, FPG=fasting plasma glucose, HDL-C=high-density lipoprotein cholesterol, HR=hazard ratio, LOS, NOS, MOS, and HOS=low, normal, moderate, and high occupational stress, LPS, NPS, MPS, and HPS=low, normal, moderate, and high personal strain, MetS=metabolic syndrome, MLCR=moderate lack of coping resources, ORQ=occupational roles questionnaire, PRQ, personal resources questionnaire, PSQ=personal strain questionnaire, SDCR=significant deficits in coping resources, TG=triglycerides.

Model adjusted=age, body mass index, marital status, office work, working strength, educational level, smoking status, alcohol intake, physical exercise, metabolic abnormalities: central obesity, raised BP, elevated TG, reduced HDL-C, and raised FPG and MetS.

Thus, we could not provide valuable conclusions about the female police population. In view of these limitations, more clinical and epidemiological studies are required to enrich and confirm our findings.

In summary, this cohort study reveal that HOS and HPS are independent predictors of NAFLD in a Chinese police population, especially among traffic control police. Systematic investigations using more accurate and noninvasive imaging techniques are warranted to confirm our conclusions and to contribute to the development of more suitable treatments and psychological interventions for NAFLD and occupational stress, consequently elucidating the need for regular screening, healthy lifestyle modifications, and stress monitoring among occupational populations.

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